Triggering in the STAR Experiment at RHIC

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The STAR collaboration was formed to investigate the behavior of matter under conditions of extremely high temperature and density at RHIC. One particular goal is to search for the existence of a deconfined state of quarks and gluons, the quark-gluon plasma. The UCB contingent in STAR is part of the group responsible for triggering the experiment. The major goals of the trigger group are:

- Analyze data from every RHIC crossing in the trigger detectors.
- Issue triggers based on the total charged multiplicity, the energy deposited in the calorimeter and the interaction position.
- Abort events based on a more detailed analysis of the trigger detector data and on data from slower detectors.
- Issue triggers to fast detectors (EMC) while the slow detectors (TPC and SVT) are busy.
- Inform DAQ when an event is ready to be built and taped.
- Implement enough scalars to enable cross-sections to be calculated.

The UCB STAR collaborators have concentrated on designing and building the custom hardware for the early levels of the trigger, and the control software for the complete trigger system.

Over the past year a prototype Data Storage and Manipulation board (DSM) and Trigger Control Unit (TCU) have been built and tested. In the final system a tree of 16-channel DSM boards will be used to store the data from the trigger detectors every RHIC crossing. The tree will also calculate triggerable quantities; total multiplicity, total energy, etc.... The output from each branch of the tree will then be collected in the last DSM board, which feeds the TCU. The prototype DSM board had just two input channels, but the rest of its functionality was the same as for the production board. A fast, high precision, TDC, used as input to one branch of the DSM tree has also been prototyped.

The prototype TCU board was very close to the final production model. The pre-scalars and trigger word look-up tables were fully implemented, and so were most of the output FIFOs. The board could also drive the trigger word on the VME backplane to be distributed to the main detector front-end electronics.

A prototype SCI-PCI (SPSB) card was designed and built for use as the internal trigger network. This should allow the trigger group to use a Scalable Coherent Interface (SCI) network to communicate between processors in many different VME crates. The prototype has been successfully used to connect the two processors that make up the trigger-daq interface.

In software, the Level 1 controller, which reads out the TCU and feeds tokens back to the TCU, and the trigger-daq interface (TDI), which informs minidaq of an event, have been written and used extensively in testing the hardware.

All the trigger pieces have now been integrated into an on-going system test at LBL, along with a TPC sector, minidaq, slow controls and experiment controls. The trigger can reliably detect a cosmic-ray induced coincidence between two scintillators placed around the TPC sector. The TCU can issue a trigger to the TPC front-end cards. Level 1 can read out the TCU FIFOs and inform minidaq that an event has occurred.

Finally, the whole STAR trigger group has just been through a successful, internal STAR review. The review committee was very impressed with the power and flexibility of the trigger system and the project can now move to the production phase.